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(54) Method and apparatus for packet data transmission

(57) In a packet data transmission and reception system two inactivity time intervals are used along with a variable data rate including an idle rate, a default or intermediate rate, and a peak rate. When no packet data is available the data rate is reduced to an idle rate to free most of the system capacity used for communicating the packet transmissions. The packet data service connection is thus maintained and the idle rate transmission of idle packets allows the receiving end of the channel to stay synchronized with the transmitter. If the packet data transmission resumes before the first inactivity timer expires the transmission rate returns immediately to the peak rate. However, if the inactivity continues until the first inactivity timer expires, the data rate is preferably not immediately returned to the peak rate. The packet data service connection is instead maintained at the idle rate after the first inactivity timer expires. When the second inactivity timer expires the packet data service is released. If packet data becomes available for transmission between the time the first inactivity timer expires and the second inactivity timer expires, the data packets are transmitted at the intermediate rate, which is generally lower than the peak rate. After the transmitting source receives an acknowledgement from the receiving end of the channel, the data rate switches back to the peak rate.

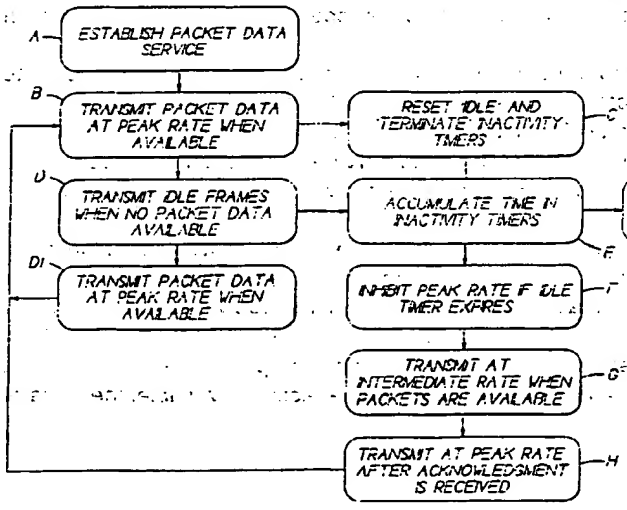

FIG. 4

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Description

This invention relates to cellular telephone network data transmission, specifically to a method of packet data transmission for a connection-based packet service.

Packet data communication is known in cellular telephone systems, as is evidenced by, for example, commonly assigned US Patent No.: 5,257,257, issued October 26, 1993, entitled "Method of Controlling the Operation of a Packet Switched CDMA Communications Network for Controlling the Operation of Transmitters and Receivers", by X. H. Chen and J. Oksman.

One further example is defined in TIA/EIA/IS-657, Packet Data Services Option for Wideband Spread Spectrum Cellular System, incorporated herein by reference. IS-657 is used along with TIA/EIA/IS-95A, Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System, and TIA/EIA/IS-99, Data Services Option Standard for Wideband Spread Spectrum Digital Cellular System, each of which is incorporated herein by reference.

A connection-based protocol is defined for packet data service in which a mobile station (MS) establishes a connection to a base station (BS). While the connection is established a traffic channel is used for communicating data between the MS and BS. Since the use of a traffic channel consumes some of the available system capacity it is important that the traffic channel only be used when needed. To achieve this objective IS-657 defines a packet data inactivity timer in section 2.2.4.1.1.2.4, titled Connected State. According to the standard, the inactivity timer is reset whenever a packet data frame is sent or received. When there is no packet data activity the inactivity timer accumulates a count. If the packet data inactivity timer expires, meaning that it reaches the maximum allowed time of inactivity, the MS releases the connection, thus freeing the traffic channel. Protocol layers above RLP, such as PPP, TCP/IP, etc., are maintained after the traffic channel is released until the packet data service is terminated.

A problem occurs with the approach specified in IS-657 if the packet data needed to be transmitted is available in bursts or otherwise is not continuously available for transmission. In this case the inactivity timer may frequently expire during the periods of packet unavailability, causing the MS to disconnect from the packet data service. When packet data is once again available for transmission the MS must re-establish the packet data service to transmit the packets. This presents a problem in that some amount of time is required to disconnect from the packet data service and then re-establish the packet data service. Information throughput is thus reduced. If the inactivity timer expiration time is lengthened to avoid the need to frequently connect and disconnect, system capacity is wasted during periods of packet inactivity.

Another problem occurs in IS-657 when the data rate is high (could be higher than that defined in IS-95), where the peak rate consumes a large percentage of system capacity. In this case, the prior art approach would go from transmitting at the idle rate during the inactivity to transmitting a packet at the peak rate, and the system must reserve the capacity of the peak rate during the entire length of the inactivity timer. This is extremely prohibitive for a service which is intended to be able to transfer capacity from one packet data user to another during times of inactivity.

According to the prior art, there is no value of the inactivity expiration time that will provide optimum packet data transmission efficiency. A short inactivity expiration time will require frequent service negotiation for connections and disconnections, and a long inactivity expiration time will waste system resources. An improved method of transmitting packet data is needed to overcome this limitation of the prior art.

This invention is directed to solving the problem of inefficient packet data transmission. According to the teaching of this invention two inactivity time intervals are used along with a variable data rate including an idle rate, a default or intermediate rate, and a peak rate. When no packet data is available the data rate is reduced to an idle rate to free most of the system capacity used for communicating the packet transmissions. The packet data service connection is thus maintained and the idle rate transmission of idle packets allows the receiving end of the channel to stay synchronized with the transmitter.

If the packet data transmission resumes before the first inactivity timer expires the transmission rate returns immediately to the peak rate. However, if the inactivity continues until the first inactivity timer expires, the data rate is preferably not immediately returned to the peak rate. This is because the network may allocate the free system capacity for other uses after the first inactivity timer expires. The packet data service connection is instead maintained at the idle rate after the first inactivity timer expires. When the second inactivity timer expires the packet data service is released.

If packet data becomes available for transmission between the time the first inactivity timer expires and the second inactivity timer expires, the data packets are transmitted at the intermediate rate, which is generally lower than the peak rate. After the transmitting source receives an acknowledgement from the receiving end of the channel, the data rate switches back to the peak rate. The data rate is not immediately switched back to the peak rate when packet data is available, because the network may have insufficient capacity to support the peak rate after reallocating capacity during the idle time. After an acknowledgement is received that sufficient capacity is available, the transmitting source may then use the peak rate.

The intermediate rate may be the same as the peak rate under certain capacity utilization conditions. In this case data rate switches to the peak rate directly from the idle rate without having to receive an acknowledge signal.

The invention provides an efficient method for transmitting packet data over a cellular communication network.

The invention maintains a packet data service connection during brief times of packet data inactivity without wasting system capacity.

The invention avoids renegotiation of service between brief times of packet data inactivity.

A feature of the invention is the use of multiple inactivity timers.

Another feature of the invention is the use of a variable data rate for packet data transmissions.

Another feature of the invention is that a packet data service connection is maintained, during periods of packet data inactivity, at an idle rate.

An advantage of the invention is that packet data throughput is maximized by avoiding the overhead associated with frequent service negotiation.

Another advantage of the invention is that available system capacity is maximized by maintaining packet data connection during inactive periods at an idle rate instead of a peak rate.

According to one aspect of the present invention, there is provided a method of transmitting packet data comprising the steps of:

establishing a packet data service connection;

transmitting the packet data at a first predetermined rate when the packet data is available;

resetting a first and a second inactivity timer when packet data is transmitted;

transmitting at least one idle frame at a second predetermined rate when packet data is not available;

incrementing the first and second inactivity timers when packet data is not being transmitted;

detecting an expiration of the first inactivity timer and, in response to the detected expiration, inhibiting packet transmission at the first predetermined rate;

transmitting packet data at a third predetermined rate when packet data is available after detecting an expiration of the first inactivity timer, but before detecting an expiration of the second inactivity timer; and

receiving an acknowledge signal and in response to the acknowledge signal transmitting packet data at the first predetermined rate;

wherein the step of detecting an expiration of the first inactivity timer includes a further step of detecting an expiration of the second inactivity timer, if no further packet data is transmitted, and, in response to the detected expiration of the second expiration timer, releasing the packet data service.

According to another aspect of the invention, there is provided a method for transmitting packet data between a packet data source and a packet data sink in a wireless transmission/reception system, comprising the steps of:

transmitting, at a first data rate, the available packet data from the source to the sink over a packet data channel;

upon an occurrence of a condition wherein packet data is not available to be transmitted, transmitting idle packet data at a second data rate from the source to the sink while running a first timer and a second timer;

while running the first timer and the second timer, and upon an occurrence of a condition wherein packet data is again available to be transmitted, and before the first timer reaches a first predetermined value, transmitting, at the first data rate, available packet data from the source to the sink;

while running the first timer and the second timer, and upon the occurrence of the condition wherein packet data is again available to be transmitted, and after the first timer reaches the first predetermined value but before the second timer reaches a second predetermined value, transmitting, at a third data rate, available packet data from the source to the sink; and

while running the first timer and the second timer, and after the first timer reaches the first predetermined value

and after the second timer reaches the second predetermined value, releasing the packet data channel.

According to another aspect of the invention, there is disclosed a wireless transmission/reception system providing for the transmission of packet data between a packet data source and a packet data sink, said packet data source comprising:

transmitter circuitry for transmitting, at one of a plurality of different data rates within a set of data rates, available, packet data to the sink over a packet data channel;

a first timer and a second timer capable of being selectively started and reset; and

a controller, said controller being coupled to said transmitter circuitry and to said timers and being responsive to an occurrence of a condition wherein packet data is available to be transmitted, for transmitting the packet data at a first data rate, said controller being further responsive to an occurrence of a condition wherein packet data becomes unavailable to be transmitted, for transmitting idle packet data at a second data rate while releasing a reset of the first timer and the second timer, said controller being further responsive to an occurrence of a condition wherein packet data again becomes available to be transmitted, before the first timer reaches a first predetermined value, for transmitting, at the first data rate, the available packet data and for resetting the first timer and the second timer, said controller being further responsive to the occurrence of the condition wherein packet data is again available to be transmitted, after the first timer reaches the first predetermined value but before the second timer reaches a second predetermined value, for transmitting, at a third data rate, available packet data and for resetting the first timer and the second timer, and said controller being further responsive to a condition wherein the first timer reaches the first predetermined value and the second timer reaches the second predetermined value, for releasing the packet data channel.

According to a further aspect of the invention, there is provided a system for the transmission and reception of packet data, over a packet data channel, at a plurality of different data rates, between a packet data source and a packet data sink, comprising :

a controller operable to :

transmit packet data at a first data rate when such packet data is available;

transmit idle packet data at a second data rate if packet data is not available;

transmit packet data at the first data rate if such packet data again becomes available before expiry of a first pre-determined time interval;

transmit packet data at a third data rate if such data becomes available after expiry of the first pre-determined time interval, but before expiry of a second pre-determined time interval;

release the packet data channel after expiry of the second pre-determined time interval if no packet data becomes available.

Figure 1 is block diagram of a cellular terminal that is suitable for practising this invention;

Figure 2 depicts the terminal of Figure 1 in communication with a cellular network;

Figures 3A-3C illustrate a timeline of events for packet data transmission according to the present invention; and

Figure 4 illustrates a flowchart of the method of packet transmission according to the present invention.

Brief reference is made to Figures 1 and 2 for illustrating a wireless user terminal or mobile station 10, such as but not limited to a cellular radiotelephone or a personal communicator, that is suitable for practising this invention. The mobile station 10 includes an antenna 12 for transmitting signals to and for receiving signals from a base site or base station 30. The base station 30 is a part of a cellular network 32 that includes a mobile switching center (MSC) 34. The MSC 34 provides a connection to landline trunks when the mobile station 10 is involved in a call. It is assumed for the purposes of this invention that the network 32 supports packet data service.

The mobile station includes a modulator (MOD) 14A, a transmitter 14, a receiver 16, a demodulator (DEMOD) 16A, and a controller 18 that provides signals to and receives signals from the transmitter 14 and receiver 16, respectively. These signals include signalling information in accordance with the air interface standard of the applicable cellular system, and also user speech and/or user generated data. The air interface standard is assumed for this invention to include a capability to convey packet data.

In the presently preferred embodiment of this invention the modulator 14A, transmitter 14, receiver 16, and demodulator 16A are adapted to operate with a direct spread, code division multiple access (DS-CDMA) system, such as one specified in IS-95A. The teaching of this invention is not, however, limited for use with only this type of system, but may be employed with a number of different types of systems having different modulation and access characteristics, such as time division, multiple access (TDMA) systems.

It is understood that the controller 18 also includes the circuitry required for implementing the audio and logic functions of the mobile station. By example, the controller 18 may be comprised of a digital signal processor device, a microprocessor device, and various analog to digital converters, digital to analog converters, and other support circuits. The control and signal processing functions of the mobile station are allocated between these devices according to their respective capabilities.

The mobile station 10 may be capable of voice transmissions also, and thus can include a user interface comprised of a conventional earphone or speaker 17, a conventional microphone 19, a display 20, and a user input device, typically a keypad 22, all of which are coupled to the controller 18. The keypad 22 includes the conventional numeric (0-9) and related keys (#,*) 22a, and other keys 22b used for operating the mobile station 10. These other keys 22b may include, by example, a SEND key, various menu scrolling and soft keys, and a PWR key. The mobile station 10 may also include a battery 26 for powering the various circuits that are required to operate the mobile station.

It should be realized that in other embodiments the mobile station 10 may function only as a data terminal for at least one of transmitting or receiving packet data. As such, in this case certain of the user interface components described above may not be included. It should also be appreciated that in some embodiments the mobile station 10 may not be mobile at all, but may be operated at a fixed location (for example, as a component of a wireless facsimile machine in an office environment).

The mobile station 10 also includes various memories, shown collectively as the memory 24, wherein are stored a plurality of constants and variables that are used by the controller 18 during the operation of the mobile station.

For example, the memory 24 may store the values of various cellular system parameters and the number assignment module (NAM). An operating program for controlling the operation of controller 18 is also stored in the memory 24 (typically in a ROM device). The memory 24 may also store packet data prior to transmission or after reception. The memory 24 includes routines for implementing the method described below in relation to Figures 3A, 3B, 3C and 4.

Packet data service options provide a mechanism of establishing and maintaining traffic channels for packet data service. A packet data service option is negotiated during call origination or at a later time during a call. The details of establishing packet data service are well known and can be found in IS-95A, IS-657, and IS-99. To implement the invention the call origination messages are modified from the definitions in these standards to include fields to hold new parameters. Specifically, the parameters in Table 1 are established between the MS and BS.

Table 1

PARAMETER	DESCRIPTION
Rate Set	The set of discrete data rates used (for example, 1.2 kbps, 2.4 kbps, 4.8 kbps, 9.6 kbps, etc. form a rate set).
Idle Rate	The data rate when no packet data is transmitted
Intermediate Rate	The data rate after an idle rate transmission.
Peak Rate	The maximum rate in the rate set that is usable.
Idle Time	The inactivity timer expiration value when the transmission rate is limited to the intermediate rate.
Terminate Time	The inactivity timer expiration value when packet data service is terminated.

Any of these parameters can be negotiated when packet data service is requested, or can be made a fixed value that is associated with the packet data service.

The Rate Set can be selected from the list of available rate sets defined in IS-95A, or from additional rate sets that are defined as part of a high speed data service. The Idle Rate can be, for example, the lowest rate in the Rate Set. The Intermediate Rate can be, for example, a basic rate of the Rate Set. The Peak Rate can be the highest rate in the Rate Set, or a lower rate if limited by the capabilities of the MS 10 or the available system capacity.

The Idle Time and Terminate Time may be determined by the network loading and the characteristics of the packet

data service. On a heavily loaded network with limited available capacity, the network may set the Idle Time short so that the inactive user's capacity can quickly be reallocated to an active user. The network reserves capacity to support the Intermediate Rate after the Idle Time expires. The Terminate Time is less critical because the actual capacity used is based on Idle Rate transmission, and the Intermediate Rate capacity being reserved by the network 32 is generally less than the Peak Rate.

Referring to Figure 3A, there is illustrated an exemplary sequence of events in a packet data service call. After a packet data service is connected 100, data packets are transmitted 110 at the Peak Rate. When no packets are transmitted the rate switches automatically to the Idle Rate 125. If packet transmission does not resume before the Terminate timer expires 130, packet service is disconnected 140 or is released.

Referring to Figure 3B, when packet transmission at the Peak Rate 200 stops, and idle frames are transmitted 210 at the Idle Rate for a period of time less than the Idle expiration time, the Peak Rate transmission 220 may resume, assuming that additional packet data becomes available for transmission.

Referring to Figure 3C, if packet transmission at the Peak Rate 300 stops for longer than the Idle expiration time 320, then the Idle Rate 310 transitions to the Intermediate Rate 330 until an acknowledgement (ACK) 340 is received. At this time the Peak Rate transmission 350 may resume. The receipt of the ACK 340 informs the transmitter that sufficient capacity exists to support the Peak Rate Transmission.

The inactivity timers can be implemented as two timers, each with an expiration time. By example, and referring to Figure 1, the timers can be implemented as software timers (Timer 1 and Timer 2) that are maintained in a read/write portion of the memory 24. Alternatively, a single timer can be used, wherein the timer value is compared with the Idle Time value to detect the first expiration. Then the single timer continues to count and the timer value is compared with the Terminate Time value to detect the second expiration.

Referring now to Figure 4, which shows a flow chart of the method of the invention, packet data service is first established at Block A. Initially packets are transmitted at, by example, the Peak Rate (Block B). When a packet is transmitted the Idle and Terminate inactivity timers are reset at Block C. During times when no packets are being transmitted, one or more idle frames are transmitted at Block D at the Idle Rate, and again at the Peak Rate (D1) if packet data becomes available before the expiration of the Idle inactivity timer. In this manner the receiver of the packet data maintains synchronization with the transmitter. During the time that the Idle frames are transmitted (Block D) the inactivity timers accumulate a count (Block E). When the Idle timer has expired (Block F) further transmission at the Peak Rate is inhibited. When packet data is available and transmission begins again (Block G), the transmission rate is set at the Intermediate Rate. When an acknowledgement is received (Block H), transmission again resumes at the Peak Rate. This process continues until the packet service is terminated by a normal service termination sequence, or by the expiration of the Terminate timer at Block I.

Although described in the context of preferred embodiments, it should be realized that a number of modifications to these teachings may occur to one skilled in the art. By example, and as was discussed above, the teachings of this invention are not intended to be limited to any specific air interface standard or access scheme.

Thus, while the invention has been particularly shown and described with respect to preferred embodiments thereof, it will be understood by those skilled in the art that changes in form and details may be made therein without departing from the spirit and scope of the invention.

The scope of the present disclosure includes any novel feature or combination of features disclosed therein either explicitly or implicitly or any generalisation thereof irrespective of whether or not it relates to the claimed invention or mitigates any or all of the problems addressed by the present invention. The applicant hereby gives notice that new claims may be formulated to such features during prosecution of this application or of any such further application derived therefrom.

Claims

1. A method of transmitting packet data comprising the steps of:

establishing a packet data service connection;

transmitting the packet data at a first predetermined rate when the packet data is available;

resetting a first and a second inactivity timer when packet data is transmitted;

transmitting at least one idle frame at a second predetermined rate when packet data is not available;

incrementing the first and second inactivity timers when packet data is not being transmitted;

detecting an expiration of the first inactivity timer and, in response to the detected expiration, inhibiting packet transmission at the first predetermined rate;

transmitting packet data at a third predetermined rate when packet data is available after detecting an expiration of the first inactivity timer, but before detecting an expiration of the second inactivity timer; and

receiving an acknowledge signal and in response to the acknowledge signal transmitting packet data at the first predetermined rate;

wherein the step of detecting an expiration of the first inactivity timer includes a further step of detecting an expiration of the second inactivity timer, if no further packet data is transmitted, and, in response to the detected expiration of the second expiration timer, releasing the packet data service.

2. The method of claim 1 wherein the first data rate is greater than the third data rate and the third data rate is greater than the second data rate.

3. The method of claim 1 or claim 2, wherein the functionality of the first and second inactivity timer is accomplished with a single timer.

4. A method for transmitting packet data between a packet data source and a packet data sink in a wireless transmission/reception system, comprising the steps of:

transmitting, at a first data rate, the available packet data from the source to the sink over a packet data channel;

upon an occurrence of a condition wherein packet data is not available to be transmitted, transmitting idle packet data at a second data rate from the source to the sink while running a first timer and a second timer;

while running the first timer and the second timer, and upon an occurrence of a condition wherein packet data is again available to be transmitted, and before the first timer reaches a first predetermined value, transmitting, at the first data rate, available packet data from the source to the sink;

while running the first timer and the second timer, and upon the occurrence of the condition wherein packet data is again available to be transmitted, and after the first timer reaches the first predetermined value but before the second timer reaches a second predetermined value, transmitting, at a third data rate, available packet data from the source to the sink; and

while running the first timer and the second timer, and after the first timer reaches the first predetermined value and after the second timer reaches the second predetermined value, releasing the packet data channel.

5. A method as set forth in claim 4, wherein the step of transmitting available packet data at the third data rate continues until a signal is received from the packet data sink, and, in response to the signal being received, resuming the transmission of the available packet data at the first data rate.

6. A method as set forth in claim 4 or claim 5, wherein the steps of transmitting occur over a direct spread, code division multiple access (DS-CDMA) packet data channel.

7. The method of any of claims 4 to 6, wherein the functionality of the first and second timer is accomplished with a single timer.

8. A method as set forth in any of claims 4 to 7, wherein the first data rate is greater than the third data rate and the third data rate is greater than the second data rate.

9. A wireless transmission/reception system providing for the transmission of packet data between a packet data source and a packet data sink, said packet data source comprising:

transmitter circuitry for transmitting, at one of a plurality of different data rates within a set of data rates, available packet data to the sink over a packet data channel;

a first timer and a second timer capable of being selectively started and reset; and

a controller, said controller being coupled to said transmitter circuitry and to said timers and being responsive to an occurrence of a condition wherein packet data is available to be transmitted, for transmitting the packet data at a first data rate, said controller being further responsive to an occurrence of a condition wherein packet data becomes unavailable to be transmitted, for transmitting idle packet data at a second data rate while releasing a reset of the first timer and the second timer, said controller being further responsive to an occurrence of a condition wherein packet data again becomes available to be transmitted, before the first timer reaches a first predetermined value, for transmitting, at the first data rate, the available packet data and for resetting the first timer and the second timer, said controller being further responsive to the occurrence of the condition wherein packet data is again available to be transmitted, after the first timer reaches the first predetermined value but before the second timer reaches a second predetermined value, for transmitting, at a third data rate, available packet data and for resetting the first timer and the second timer, and said controller being further responsive to a condition wherein the first timer reaches the first predetermined value and the second timer reaches the second predetermined value, for releasing the packet data channel.

10. A system as set forth in claim 9 wherein said first and second timer may be implemented as a single timer.

11. A system as set forth in claim 9 or claim 10, wherein said controller transmits available packet data at the third data rate until a signal is received from the packet data sink, and, in response to the signal being received, for resuming the transmission of the available packet data at the first data rate.

12. A system as set forth in any of claims 9 to 11, wherein said transmitter is adapted for transmitting over a direct spread, code division multiple access (DS-CDMA) packet data channel.

13. A system as set forth in any of claims 9 to 13, wherein the first data rate is greater than the third data rate and the third data rate is greater than the second data rate.

14. A system for the transmission and reception of packet data, over a packet data channel, at a plurality of different data rates, between a packet data source and a packet data sink, comprising :

a controller operable to :

transmit packet data at a first data rate when such packet data is available;

transmit idle packet data at a second data rate if packet data is not available;

transmit packet data at the first data rate if such packet data again becomes available before expiry of a first pre-determined time interval;

transmit packet data at a third data rate if such data becomes available after expiry of the first pre-determined time interval, but before expiry of a second pre-determined time interval;

release the packet data channel after expiry of the second pre-determined time interval if no packet data becomes available.

15. The system of claim 14, wherein the controller causes packet data to be transmitted from the packet data source at the third data rate until a signal is received from the packet data sink, and then causing the available packet data to be transmitted at the first data rate.

16. A system as set forth in claim 14 or claim 15 wherein the first data rate is greater than the third data rate and the third data rate is greater than the second data rate.

FIG. 1

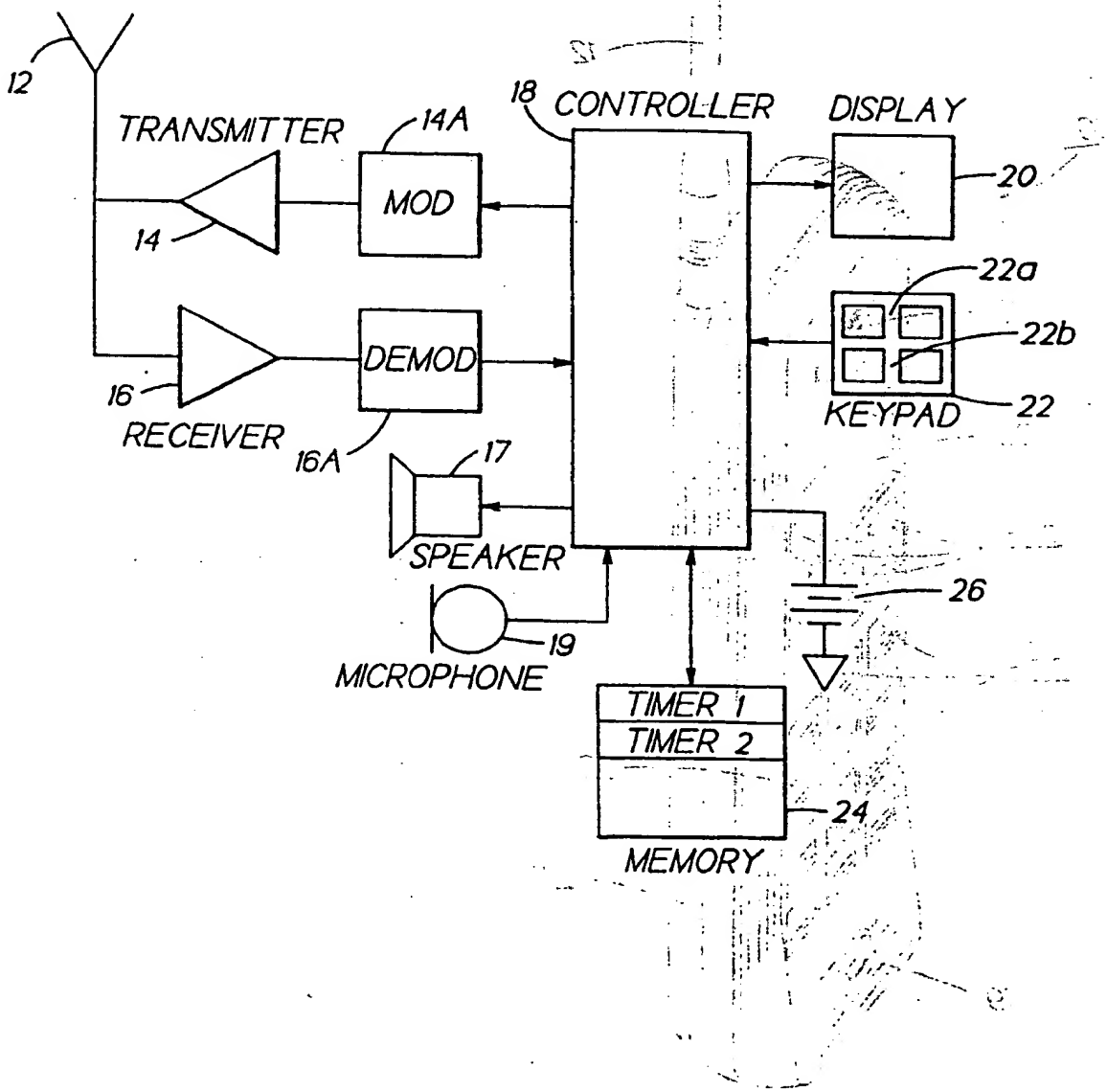


FIG. 2

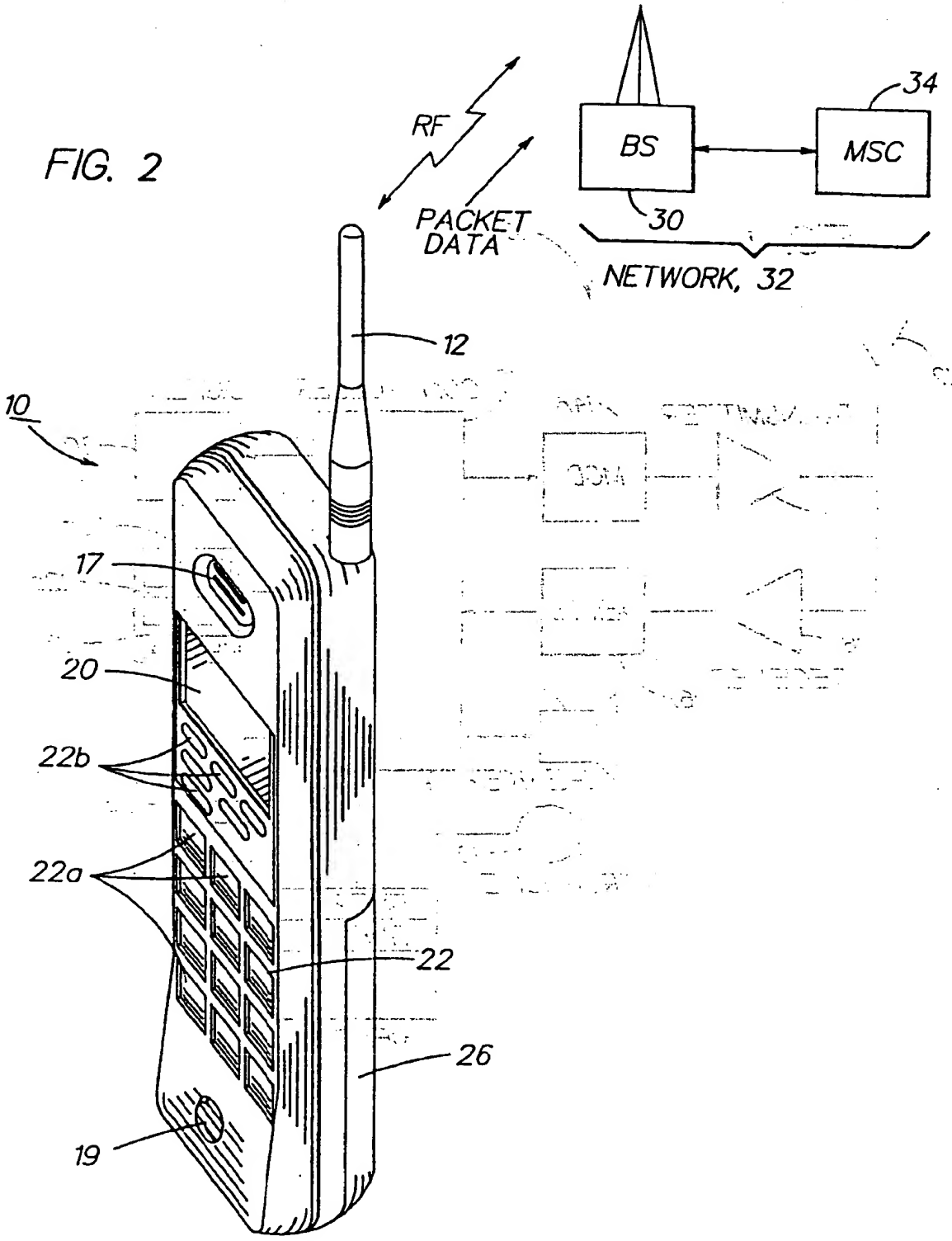
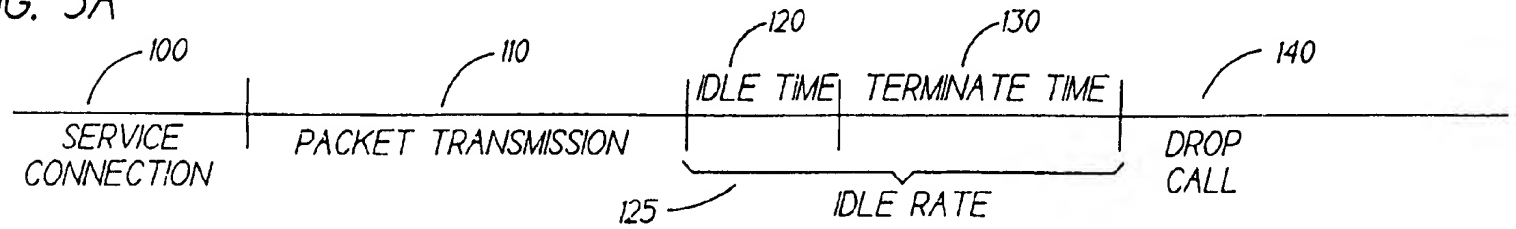
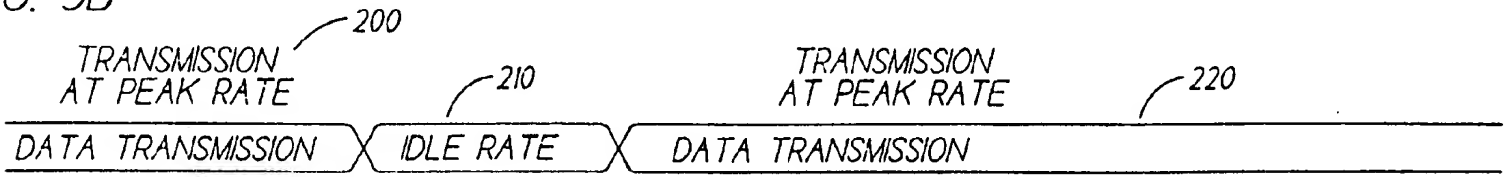


FIG. 3A



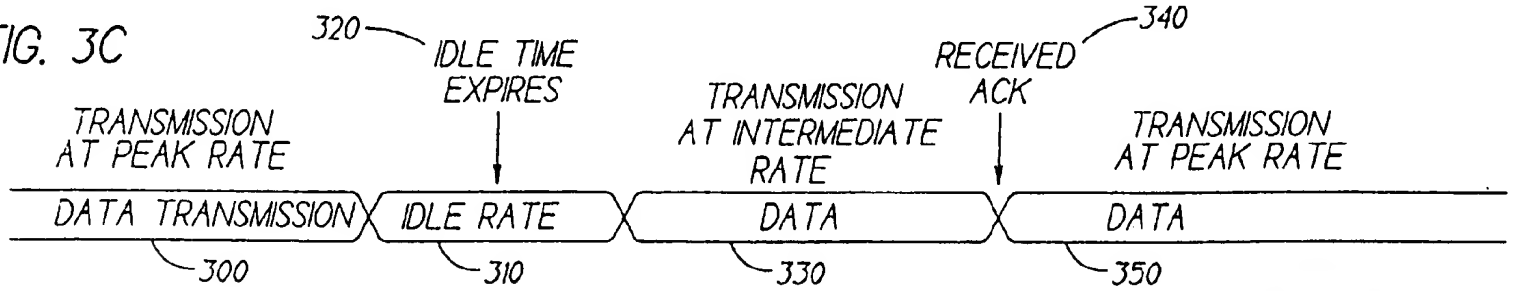
PACKET TRANSMISSION TIME LINE

FIG. 3B



PACKET TRANSMISSION BEFORE IDLE TIME EXPIRES

FIG. 3C



PACKET TRANSMISSION AFTER IDLE TIME EXPIRES AND BEFORE TERMINATE TIME

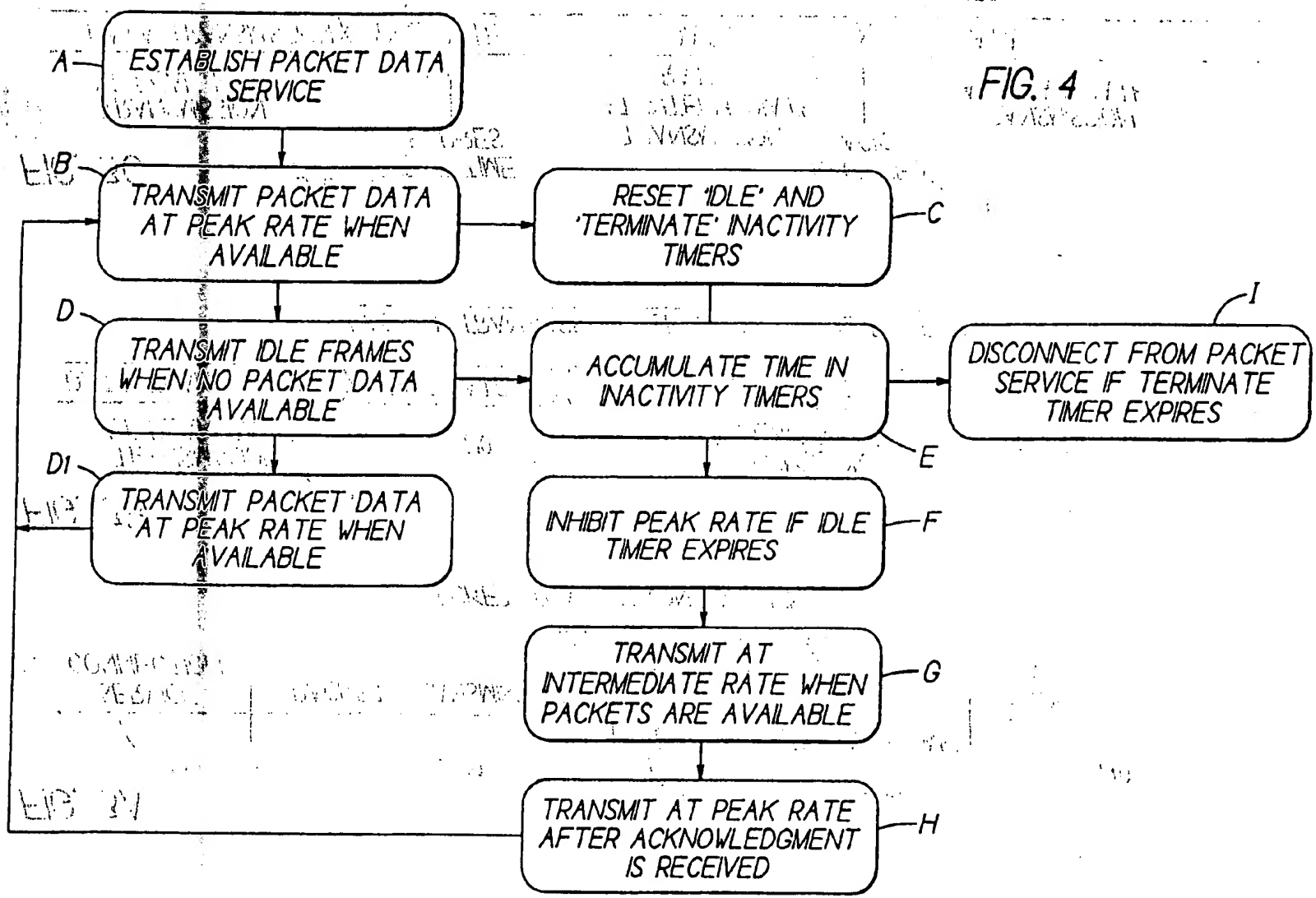


FIG. 4

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(54) Method and apparatus for packet data transmission

(57) In a packet data transmission and reception system two inactivity time intervals are used along with a variable data rate including an idle rate, a default or intermediate rate, and a peak rate. When no packet data is available the data rate is reduced to an idle rate to free most of the system capacity used for communicating the packet transmissions. The packet data service connection is thus maintained and the idle rate transmission of idle packets allows the receiving end of the channel to stay synchronized with the transmitter. If the packet data transmission resumes before the first inactivity timer expires the transmission rate returns immediately to the peak rate. However, if the inactivity continues until the first inactivity timer expires, the data rate is preferably not immediately returned to the peak rate. The packet data service connection is instead maintained at the idle rate after the first inactivity timer expires. When the second inactivity timer expires the packet data service is released. If packet data becomes available for transmission between the time the first inactivity timer expires and the second inactivity timer expires, the data packets are transmitted at the intermediate rate, which is generally lower than the peak rate. After the transmitting source receives an acknowledgement from the receiving end of the channel, the data rate switches back to the peak rate.

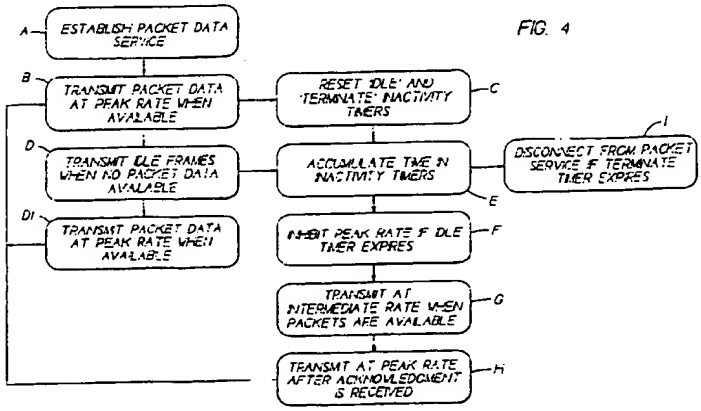

FIG. 4

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 7042

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	16 September 1999	Leouffre, M

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